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VOLUME XXII. NUMBER 5

SEPTEMBER, 1949

A Post-war Grinding Mill.

A NEW clinker-grinding mill at the Holborough Works of the Associated Portland Cement Manufacturers, Ltd., started production in October, 1947, and by July, 1949, it had ground more than 200,000 tons of clinker, so that it is now possible to judge its performance and capabilities.

Design.

The mill is 40 ft. long by 7 ft. 6 in. diameter inside the shell. It is a compound mill with a trunnion feed and discharge.

SHELL AND BEARINGS.—*Fig. 1* is a view of the mill from the feed end (the feed arrangements are not shown), and *Fig. 2* is a section through the mill. The shell is of 1½ in. plate with welded joints, the ends being riveted to the shell and the trunnions bolted to the ends. The ends have internal stiffened ribs which, in the case of the outlet end, are used as lifters to convey the cement from the delivery side of the outlet diaphragm to the outlet trunnion of the mill (see *Fig. 2*). The main trunnion bearings are the self-aligning type, and are lubricated by discs fixed to the trunnion which pick up oil from a sump and deliver it to a trough over the top of the bearing. There is no external oil pump. Illuminated glass panels give the mill attendant a view of the bearings and their lubrication. *Fig. 3* shows the outlet trunnion and the attendant inspecting the lubrication. *Fig. 5* gives sections through the trunnion bearings.

DRIVE.—The drive is by means of an 800-h.p. 750-r.p.m. auto-synchronous motor running on a 3,000-volt 3-phase 50-cycles supply and is operated with a leading power-factor of 0.96. The switchgear is a 3,000-volt truck cubicle complete with volt-meter, ammeter, power-factor meter, kilowatt-hour meter and thermal relay with a liquid rotor starter and exciter panel. *Fig. 4* shows the truck cubicle and electrical instruments.

In the foreground of *Fig. 6* is the mill motor. The motor is direct coupled to a double reduction gear which reduces the speed to 21.011 revolutions per

minute, the reduction gear driving the mill centrally through a torsion shaft with diaphragm couplings. Behind the motor in *Fig. 6* is seen the reduction gear. The height from floor level to the top of the gear casing is 14 ft. 9 in. *Fig. 7* shows the torsion shaft and diaphragm couplings. The inlet end of the mill is fitted with a 4-ft. diameter double-scroll type of drum feeder which ensures an even feed to the mill and helps to prevent fluctuations. The drum feeder is shown in *Figs. 8* and *9*.

THE COMPARTMENTS AND LINING.—The mill is divided into three chambers. The inlet-end chamber is 11 ft. 1 $\frac{3}{8}$ in. long, the intermediate chamber is 7 ft. 1 $\frac{3}{8}$ in

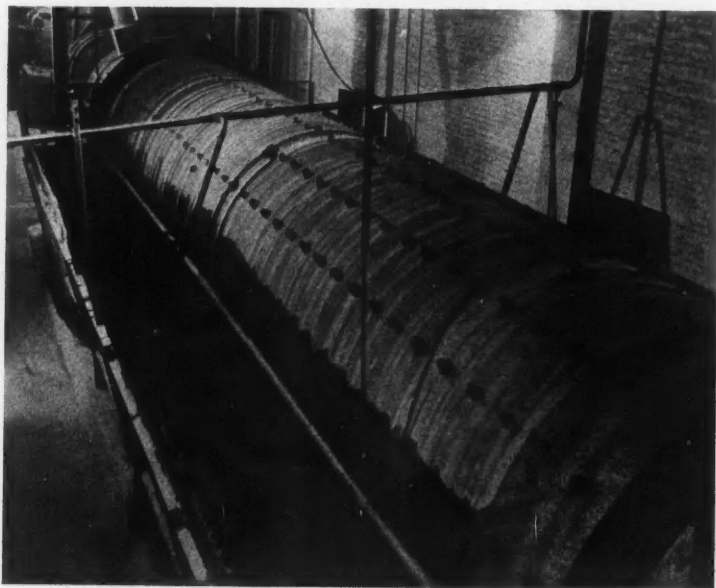


Fig. 1.—View of Mill from Feed End.

long, and the outlet chamber is 18 ft. 9 $\frac{1}{2}$ in. long. The inlet and intermediate chambers are separated by a double-lifter diaphragm and the intermediate and outlet chambers by a plate diaphragm (see *Fig. 10*). There are four manholes, one to each of the inlet and intermediate chambers and two to the outlet chamber; these are oval and similar to those used for boilers. Cement-tightness and water-tightness are obtained by grease packing between the shell and cover. The manholes are in line on one side of the mill only (*Fig. 11*). The out-of-balance weight of the four manholes is about 11.3 cwt., which is from one-half to two-thirds of the more common type of rectangular cover formerly used. No difficulty has been experienced in opening or closing these manholes for inspecting the lining or adding grinding media.

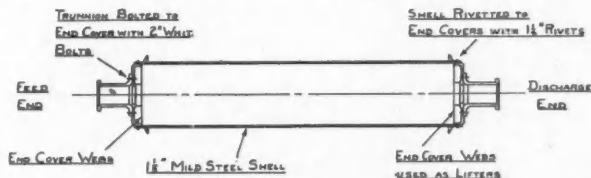


Fig. 2.—Section through Shell.

The inlet-end wall (*Fig. 12*) incorporates a renewable wearing pad made of steel with a Brinell hardness number of about 500. It was hoped that the wear would be taken on these pads which could be easily replaced when worn and so obviate the necessity of renewing the whole wall; present indications are that this hope may not be realised. The inlet-end chamber is lined with grooved plates of special cast iron with a Brinell hardness number of about 500 and an average thickness of $3\frac{1}{2}$ in. The grooved type of liner (*Fig. 13*) was designed with the object of having the inside of this chamber as smooth as possible while at the same time avoiding slipping of the charge. In the intermediate chamber a similar type of grooved plate is used, also with a high Brinell number but the thickness is reduced to an average of 2 in. The plates of these two chambers are held by two bolts, and the drilling of the shell is such that in an emergency plates



Fig. 3.—Outlet Trunnion and Door for Inspecting Bearings.

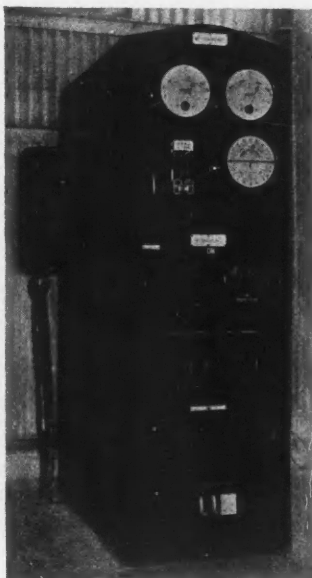


Fig. 4.—Truck Cubicle and Electrical Instruments.

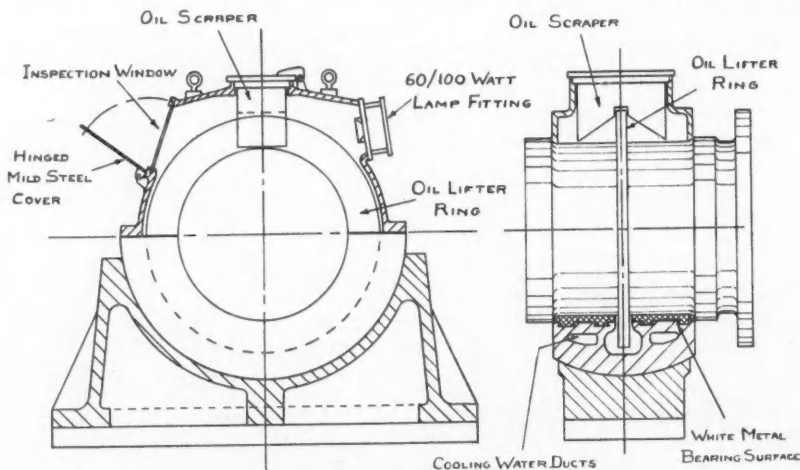


Fig. 5.—Sections Through Trunnion Bearings.

are interchangeable between the inlet and intermediate chamber, and the diaphragm between the inlet and the intermediate chamber may be moved without additional drilling.

The lining in the outlet chamber is made up of bars of cast iron held in position by a wedge-shaped key-bar bolted to the shell. The hard cast-iron bars are $1\frac{1}{2}$ in. thick. The key-bars are arranged so that they are about 1 in. proud of the lining so as to prevent the grinding media from slipping (*Fig. 14*).

The mill has no screen. Small or broken media which pass the outlet diaphragm are removed by a vibrating screen before the hopper over the cement-packing machine.

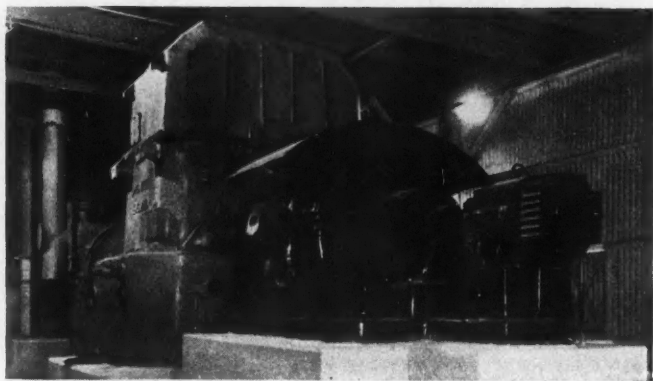


Fig. 6.—Motor and Reduction Gear.

GRINDING MEDIA.—The mill is loaded to absorb the total output of the motor. The media charge occupies 33 per cent. of the volume of the mill, and weighs 58½ tons. The media charge was determined so that the mill was capable of grinding both ordinary Portland cement and rapid-hardening Portland cement, the ordinary Portland cement having a surface area greater than 3,000 square centimetres per gramme and the rapid-hardening Portland cement having a surface area greater than 4,300 square centimetres per gramme.

The inlet chamber contains 5½ tons each of 3½-in., 3-in., and 2½-in. diameter steel balls. The intermediate chamber contains 5¾ tons each of 2-in. and 1½-in. diameter steel balls. The outlet chamber contains 7½ tons of 1-in. and 23 tons of ¾-in. white metal balls.

VENTILATION PLANT.—This plant is capable of dealing with 1,300 cu. ft. of

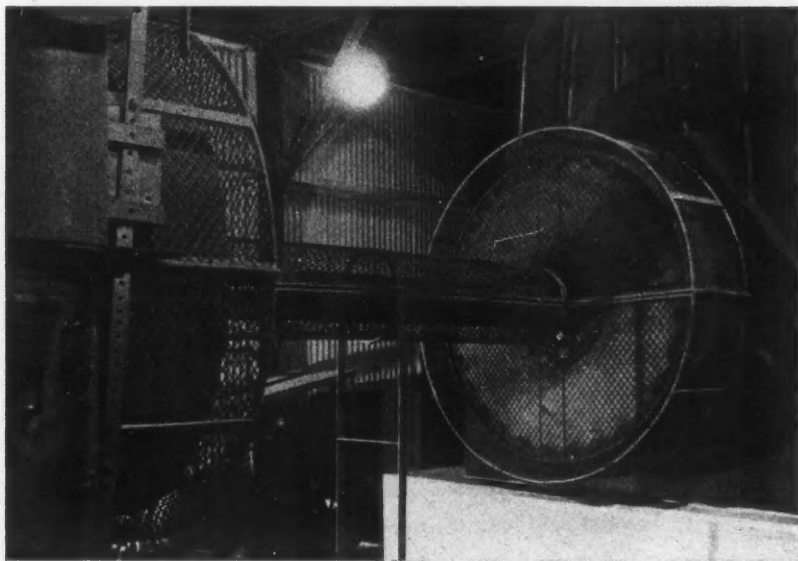


Fig. 7.—Torsion Shaft and Diaphragm Couplings.

air a minute. It is fitted with woollen filtering "stockings" which are automatically cleaned in groups with pre-heated air, the cement which is collected being returned to the conveying system through a rotary seal. *Fig. 15* shows the general arrangement of the ventilating plant. Three compartments are connected to the exhaustor while one compartment is connected to the scavenging air fan for cleaning the stockings.

THE FEED.—Clinker and gypsum are stored in hoppers over the mill, the clinker hopper having a capacity of 80 tons and the gypsum hopper 18 tons.

The clinker is uncrushed and used as it leaves the cooler. The gypsum passes a $\frac{1}{2}$ -in. mesh. The clinker and gypsum are fed to a 24-in. troughed conveyor belt which discharges through a cast-iron pipe to the drum feeder at the inlet of the mill. The cast-iron pipe is seen in the foreground of *Fig. 8*.

The gypsum feed is controlled by an adjustable volume-feeder between the outlet end of the gypsum hopper and the troughed conveyor. Clinker is fed to the mill by a short belt driven by a variable-speed motor. All the clinker and gypsum pass over an automatic weigher situated on the feed belt between the hoppers and the mill, and the weight is recorded by a counter.

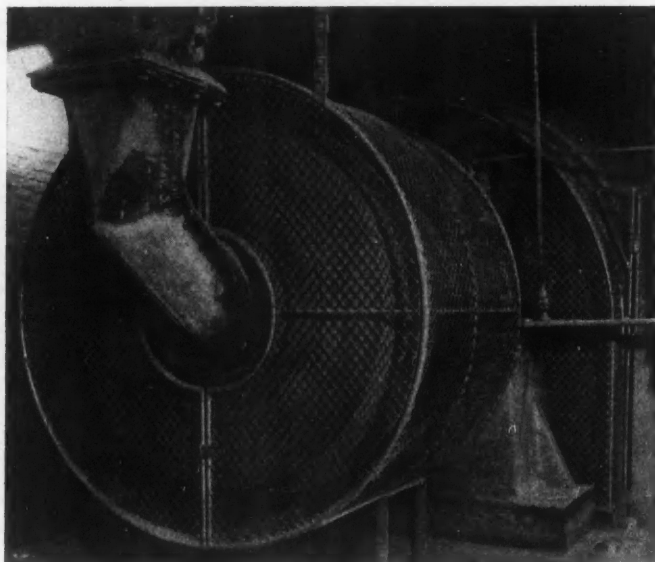


Fig. 8.—Drum Feeder.

COOLING.—The mill is water-cooled by a spray (*Fig. 1*) which runs the length of the mill on the rising side; about 3,400 gallons of water at 50 deg. F. are used an hour.

Performance.

The mill started production with 80 per cent. of the full charge of media and the remainder was added over a period of fourteen days. The ventilating plant gave some trouble until steps were taken to keep the temperature of the air extracted from the mill above its dew-point while passing through the collector.

Up to July, 1949, the mill has operated for a total of 13,295 hours, 9,715 hours on ordinary Portland cement and 3,580 hours on rapid-hardening Portland cement. It had ground a total of 219,088 tons of clinker plus gypsum of which

179,739 tons was ordinary Portland cement and 39,349 tons rapid-hardening Portland cement; this was an average output of $18\frac{1}{2}$ tons per hour of ordinary Portland cement and 11 tons per hour of rapid-hardening Portland cement.

Every attempt is made to keep the charge such that the motor is run to capacity. The mill is stopped and opened every fourteen days for an inspection of plates and diaphragms and for the addition of media. After a stop for the

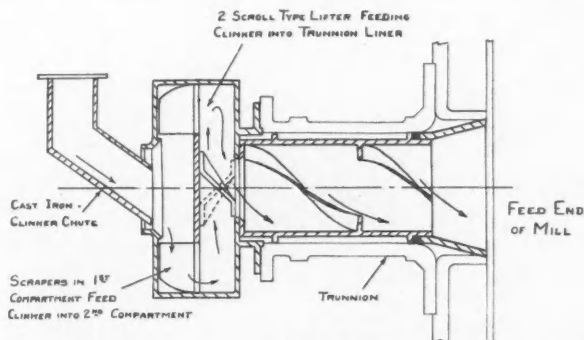


Fig. 9.—Two-compartment Drum-feeder and Mill Trunnion.

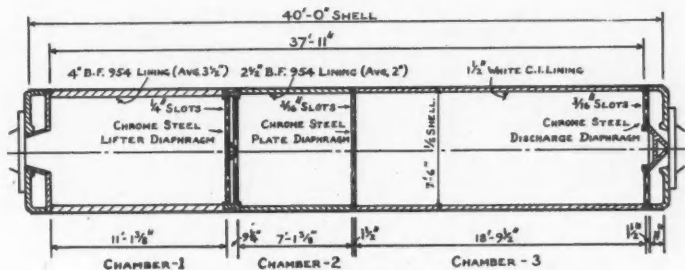


Fig. 10.—Section Showing Position of Diaphragms.

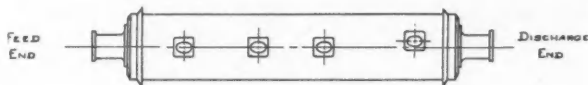


Fig. 11.—Position of Manholes.

addition of media the mill restarts with a motor output of 800 to 810 h.p., which falls to 775 to 785 h.p. by the time the next inspection is due.

Replacements of media have been recorded, and so far show a total consumption of 1.49 lb. of metal per ton of cement ground, made up of 0.84 lb. of steel balls and 0.65 lb. of cast-iron balls. It is thought that these quantities are

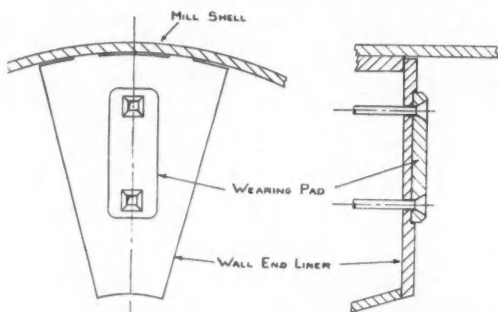


Fig. 12.—Inlet Wall Liner and Wearing Pad.

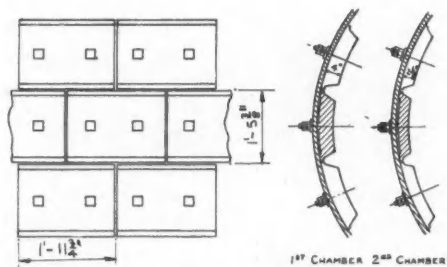


Fig. 13.—Liners of First and Second Chambers.

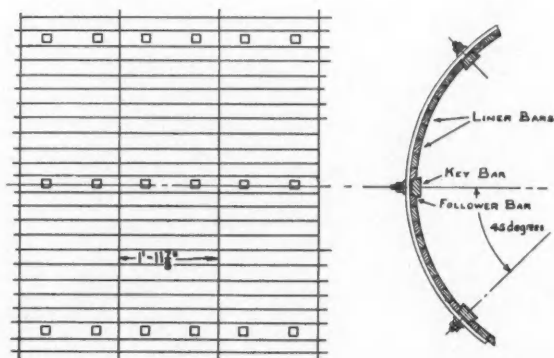


Fig. 14.—Liner Bars and Key Bars of Third Chamber.

high, particularly in the case of the cast-iron balls, but it may be that the quality of cast-iron media is inferior to that of pre-war days.

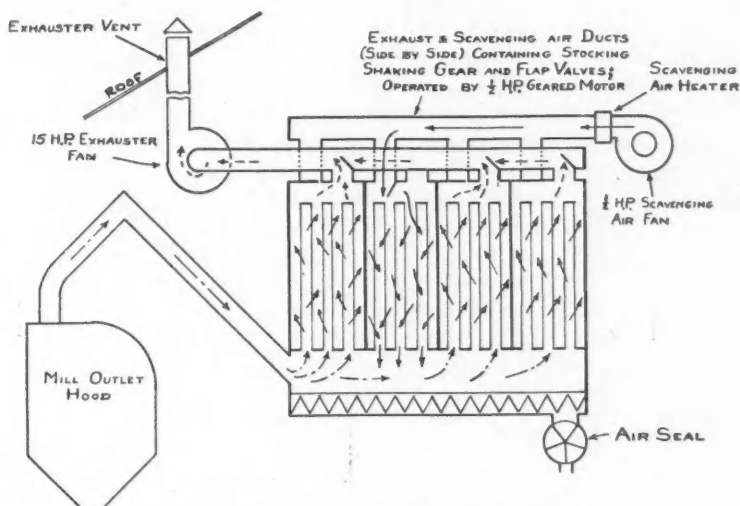


Fig. 15.—Arrangement of Ventilating Plant.

The design, workmanship, and performance of this mill, which is thought to be the first clinker-grinding mill to be installed in a cement works in Britain since the war, are of a very high order.

Gypsum in Australia.

THE Waratah Gypsum Pty., Ltd., which at present works a gypsum deposit at Stenhouse Bay, Yorke Peninsular, South Australia, is to work a newly discovered deposit at Kowulka, west of Adelaide. The cost of the development, which is being assisted by the government of South Australia, is estimated at £400,000. It is estimated that the deposit contains nearly 800 million tons of gypsum with more than 94 per cent. calcium sulphate content. The intention is to mine at the rate of 200,000 tons a year, which will supply all the requirements of Australia and leave a margin for export.

Brazilian Portland Cement Specifications and Methods of Testing.

Sr. M. A. Teixeira de Castro, of Sao Paulo, writes as follows :

The publication in "Cement and Lime Manufacture," in a tabulated form, of the standard specifications for Portland cement now in use in various countries has a great value for reference and study. The requirements for compressive strength appear to be very variable, in some cases low and in others high. This is, of course, explained by the different methods followed for the mechanical testing of cement. The mixture and the nature of the mortar, the procedure followed in making the specimens, and the shape and size of the specimens, are important factors influencing the results.

Without wishing to enter into the merits of any particular specification or method of testing, I would like to make a few remarks concerning the standard specifications and methods of testing Portland cement in Brazil. Table V on pages 70 to 73 of this journal, July 1949, gives details for the preparation of specimens for strength tests, and one can see how the method of testing is related to the strength requirements. Although the loaded area is mentioned, from which the shape of cross-section may be inferred, in most cases the shape and size of the specimens is not given. These are in general cubes. This is partly responsible for the lower strength requirements in Brazil in relation to many other countries. (Cylinders, the height of which is twice the diameter, are used in Brazil and Uruguay.)

Also, the nature and consistency of mortars, that is whether plastic or a damp harsh mixture subjected in the moulds to the blows of a standard hammer, will give wide variation in strength due to the different water-cement ratios, as may be seen by comparing Table V with Table III or Table IIIA (this journal for May, 1949, pp. 50 and 51, and July, 1949, pp. 64 to 66).

The mortar used in Brazil for the compressive test, as specified by the standard method of testing Portland cement (MB-1, 1937) is plastic, and the quantity of water as determined by a flow-table is such that 3 sand : 1 cement mortar made in a truncated-cone shaped mould and subjected to 30 drops in 30 seconds, will spread from 12.5 cm. to 16.5 cm. diameter, that is, an increase of 32 per cent. This consistency is generally obtained with a water-cement ratio of about 0.5, which seems to bear no known relation to N , that is to the percentage of water required to form a paste which permits the 1-cm. diameter Tetmajer plunger to settle at 6 mm. from the base. The formula $N + 2.5$ in the column in Table V giving the percentage of water to be used in mortar for compressive tests, does not therefore apply; it does not appear in the Brazilian standard method for testing cement (MB-1, 1937) and should therefore be deleted. According to this formula the quantity of water would be about 9 per cent. of the combined weight of cement and sand, whereas its real quantity, as ascertained by the flow-table method described in the Brazilian specification, is about 12

per cent. This relatively large quantity of water, in comparison with the quantity required for the preparation of specimens for strength tests in some other specifications, is the reason why the Brazilian requirements may appear to be lower.

The method of filling the moulds also has a great influence on the results. The more the mortar is tamped and compacted the higher is the strength within certain limits. But the manner of filling the moulds, by laying, tamping, beating, hammering, or even vibrating, cannot be prescribed, as this procedure must be related to the nature and consistency of the mortar. A very dry and harsh mortar is, in many cases, repeatedly hammered even after exudation. The 3 sand : 1 cement mortar is placed in cylindrical moulds 5 cm. diameter and 10 cm. long, according to the Brazilian standard (MB-1, 1937) by the aid of a spatula, in four layers of about equal depth, each layer receiving 30 moderate tamps by the standard tamper only in order to distribute the mortar. The mortar is not therefore compacted, nor is exudation intended to take place. The standard tamper or pestle is of metal of circular cross section. At the bottom it is 2.5 cm. diameter and 3.5 cm. long, and the upper part is 1.6 cm. diameter and 13.5 cm. long, with a total length of 17 cm. This method gives about the same compressive strength as that of workable concrete with the same water-cement ratio if it is properly proportioned, placed and cured.

New and Revised Belgian Standards for Cements.

REVISED standards were published in Belgium in April, 1949, for the following types of cements : NBN-48, Portland cement, including ordinary, high-strength, and rapid-hardening Portland cements ; NBN-49, Slag cement, including ordinary cement and two types of special cements. New standards published at the same time are : NBN-130, Blastfurnace-Portland cement, ordinary and high-strength ; NBN-131, Metallurgical cement (" ciment permétallurgiques "), ordinary and special. Methods of testing are described in NBN-178 (1949).

Portland Cement.

The requirements of the standards of 1941 as given in this journal for May and July, 1949, are altered only in the respects that follow. Strengths at 28 days are specified for rapid-hardening Portland cement ; these are : tensile, 455 lb. per square inch (32 kg. per square centimetre) ; compressive 8,178 lb. per square inch (575 kg. per square centimetre). The fineness is measured on a sieve (A.S.T.M. series) having an aperture of 0.088 mm., the diameter of the wire being 0.058 mm. to 0.073 mm. ; the maximum permissible residue remains 18 per cent. for ordinary, 14 per cent. for high-strength, and 10 per cent. for rapid-hardening Portland cement. The standard sand for the strength-test specimens is graded from 1 mm. to 0.5 mm.

Blastfurnace-Slag Cements.

Cements containing blastfurnace slag may have no admixture other than sulphates in such quantities that the SO_3 -content does not exceed 3 per cent. in

slag cement and blastfurnace-Portland cement, and 4 or 5 per cent. in metallurgical cements. No limiting specific gravity or MgO-content is specified. The strengths are given in *Table No. 1*. The soundness and setting times are the same as for Portland cement.

SLAG CEMENT.—Slag cement is produced from a mixture of slaked lime and basic blastfurnace slag containing at least 75 per cent. (by weight) of slag. The maximum permissible residues (on a sieve of the same size as for Portland cement)

TABLE I

Type of cement	Tensile strength. Age of specimen in days			Compressive strength. Age of specimen in days		
	3	7	28	3	7	28
Slag cement :						
O	—	185 (13)	256 (18)	—	1849 (130)	2560 (180)
HS	—	256 (18)	327 (23)	—	2845 (200)	3911 (275)
HS-400	256 (18)	327 (23)	384 (27)	2845 (200)	4267 (300)	5689 (400)
Blastfurnace-Portland cement :						
O	256 (18)	327 (23)	384 (27)	2845 (200)	4267 (300)	5689 (400)
HS	327 (23)	384 (27)	427 (30)	4267 (300)	5689 (400)	7112 (500)
Metallurgical cement : O and special ..	—	256 (18)	327 (23)	—	2845 (200)	4267 (300)

Strengths are expressed in pounds per square inch ; values in brackets are kilogrammes per square centimetre.

are 18 per cent. for ordinary, 10 per cent. for special cement, and 5 per cent. for "special-400" slag cements.

BLASTFURNACE-PORTLAND CEMENTS.—Blastfurnace-Portland cement is produced from a mixture of blastfurnace slag and Portland cement clinker, the cement containing from 30 per cent. to 70 per cent. (by weight) of slag. The maximum permissible residues are 10 per cent. for ordinary blastfurnace-Portland cement and 5 per cent. for high-strength blastfurnace-Portland cement.

METALLURGICAL CEMENT.—Metallurgical cement is produced from a mixture of blastfurnace slag and Portland cement clinker and contains at least 70 per cent. (by weight) of slag. The maximum permissible residue is 14 per cent.

Production of Cement in Spain.

THE production of Portland cement in Spain in 1948 was about 1,674,000 tons, compared with about 1,694,000 tons in 1947. The sales were about 1,713,000 tons, compared with 1,704,000 tons in 1947. The sales of special cements were about 153,400 tons, which is 11½ per cent. more than in 1947.

Chemical Analysis in the Cement Industry.*

Fuel.

The methods of sampling and analysis of solid fuels are described in British Standard No. 735 (1944), from which some of the following details are abstracted.

SAMPLING.—The size of the gross sample depends upon the normal ash content, the normal maximum size of the coal, and the accuracy required, and not upon the size of the consignment. The gross sample should be taken in accordance with the increments shown in Table Ia, p. 9, of the Standard. The bin or bins for the gross sample should, as far as possible, be kept closed and cool to avoid evaporation of moisture.

In the case of large coal the gross sample should be quickly crushed to about 2 in. size. The gross sample should then be thoroughly mixed, coned, and flattened, and a sample for moisture tests taken by at least ten increments of 1 lb. for coal up to 1 in. and of 2 lb. for coal up to 2 in. The remainder of the gross sample should be crushed or ground to $\frac{1}{4}$ in. or finer, mixed by coning, and reduced to a 10-lb. sample either by a sample divider or by quartering. This 10-lb. sample should then be ground to pass a 14-mesh B.S. sieve, air-dried, thoroughly mixed, and again reduced to a 2-lb. sample, preferably by a mechanical sample divider. The 2-lb. sample should be ground to pass a 36-mesh B.S. sieve, mixed, and reduced to a 4-oz. sample, which is then ground to pass a 72-mesh B.S. sieve, mixed, and stored in an airtight bottle for analysis.

DETERMINATION OF MOISTURE.—The moisture sample in its container is weighed, and the sample spread on suitable trays. It is then air dried at a maximum temperature of 50 deg. C. until the change in weight does not exceed 0.1 per cent. per hour. The sample container is dried and weighed with the sample and the total loss in weight of the sample and the container is expressed as a percentage of the original weight of the sample. This is reported as x , the loss of weight in air drying.

The air-dried sample is then ground, without exposing it to changes of temperature and humidity, to pass a 6-mesh B.S. sieve, mixed thoroughly, and a portion taken for moisture determination by the following method. Ten grammes of the air-dried coal are weighed in a shallow vessel provided with a well-fitting cover. The uncovered coal is heated for one hour at a temperature of 105 to 110 deg. C. in a suitable form of drying oven in which the free space is reduced to a minimum and through which a current of nitrogen freed from oxygen is passed during the heating period. The vessel is then removed from the oven, covered, and allowed to cool in a desiccator charged with concentrated sulphuric acid. When cool the covered vessel is weighed and the percentage loss in weight y is the percentage of moisture.

The total moisture content of the sample is $x + y(1 - \frac{x}{100})$, where x is the percentage loss of weight in air-drying and y is the percentage moisture in the air-dried sample.

* Concluded from March, May and July, 1949.

DETERMINATION OF VOLATILE MATTER.—One gramme of the air-dried coal, ground to pass a 72-mesh B.S. sieve, is placed in a weighed silica crucible about 38 mm. high and 22 mm. internal diameter. The crucible is covered with a weighed close-fitting lid of the capsule type. The crucible is then tapped on a hard surface so that the coal forms a layer of even thickness on the bottom. The covered crucible is then inserted in a muffle furnace, the temperature of which has previously been adjusted to a steady value of 925 deg. C. as indicated by a thermocouple placed as near as possible to the position in which the crucible is to stand. The crucible is heated for exactly seven minutes from the time of insertion, then removed from the furnace and cooled rapidly, at first upon a cold iron slab and finally in a desiccator. Weigh and express the loss in weight as a percentage of the weight of coal taken and deduct from this the percentage of moisture present.

DETERMINATION OF ASH.—One to two grammes of the air-dried coal, ground to pass a 72-mesh B.S. sieve, are weighed in a shallow platinum, porcelain, or silica dish 20 to 40 sq. cm. in area. The crucible and contents are slowly heated in a muffle furnace until the volatile matter has been expelled, and the temperature is then raised to 775 deg. C. \pm 25 deg. C. at which temperature the coal should be heated in an oxidising atmosphere until it is constant in weight. The dish is then covered, cooled in a desiccator, and weighed. The weight of ash is expressed as a percentage of the weight of coal taken.

DETERMINATION OF CALORIFIC VALUE.—The calorific value may be determined either by a high-pressure bomb calorimeter of the Berthelot type or by the Roland Wild apparatus. For the former the determination may be made on the air-dried sample, but with the Roland Wild apparatus the coal should be previously dried at 105 to 110 deg. C. and weighed as rapidly as possible. Details of the method of operation of both these types of apparatus are supplied with the instruments.

The calorific value as determined with these instruments is the gross calorific value under condition of constant volume. From this value the net calorific value is calculated by deducting the latent heat of the water condensed from the products of combustion by cooling to 60 deg. F., it being assumed that the whole of the hydrogen in the fuel has been burnt to water and that the percentage of hydrogen in the fuel is known.

The foregoing determinations are what is generally known as the proximate analysis of the fuel, the difference between 100 and the sum of the determined percentages of moisture, volatile matter, and ash being termed "fixed carbon." A more detailed analysis of the fuel comprises, in addition, determinations of hydrogen, carbon, nitrogen, carbon dioxide, and sulphur, and are not given in B.S. No. 735.

CARBON AND HYDROGEN are estimated in the type of apparatus described in the method for carbon determination under "Argillaceous materials."* About 0.5 gr. of the air-dried coal is burnt in the tube furnace and the products of combustion—

* In this journal, May, 1949.

carbon dioxide and water—are absorbed in their respective absorption vessels. From the respective weights of carbon dioxide and water obtained the percentages of carbon and hydrogen in the fuel are calculated, the amount of moisture in the air-dried sample having been deducted.

CARBON DIOXIDE.—This is estimated as described under “Argillaceous Materials.” in this journal, May, 1949.

SULPHUR.—This may be determined on the products of combustion obtained from the determination of the calorific value. If the high-pressure bomb calorimeter is used, the contents of the bomb are washed into a beaker, washing out the valve and crucible and also including any deposit of lead sulphate on the washer. A dilute solution of sodium carbonate is added until the solution is slightly alkaline, boiled for a few minutes, and filtered through a double 9-cm. No. 40 Whatman filter paper, and the residue well washed with hot water, the filtrate being retained for determination of sulphate. Before precipitation of the barium sulphate by barium chloride, the filtrate is acidified and brought to the boil.

If the Roland Wild type of calorimeter is used, the fused mass is extracted and dissolved in water in a 6-in. porcelain dish. When solution is complete, the liquid is cooled and treated with 2 to 3 cc. of bromine, followed by about 40 cc. of concentrated hydrochloric acid, the latter being added cautiously. After the violent reaction has finished, the solution is boiled, filtered through a double 9-cm. No. 40 Whatman filter-paper, and the residue well washed with hot water.

The filtrate from either of these extractions is boiled and the sulphate is precipitated by barium chloride and then allowed to stand in a warm place for six hours before it is filtered, washed, dried, and ignited.

The weight of barium sulphate $\times 0.1373$ is the weight of sulphur.

NITROGEN.—One gramme of the sample is weighed into a Kjeldall flask, a small globule of mercury is added, followed by 25 cc. of concentrated sulphuric acid and 10 gr. of potassium sulphate, and the whole thoroughly mixed by shaking. The flask is placed in a fume cupboard over a low flame and heated until all the fuel has been acted upon and the liquid is of a pale straw colour. When quite cold it is diluted with about 250 cc. of cold distilled water, the flask being kept cool under a stream of cold water. A few drops of methyl orange indicator are added, and the flask attached to a distillation apparatus; 100 cc. of 50-per cent. caustic potash are then added slowly from a bulb funnel fitted to the Kjeldall flask and protected from the ingress of any ammonia from the atmosphere. The liquid is heated to boiling and the evolved ammonia absorbed in a known volume of $N/2$ standard sulphuric acid. The distillation is continued until about 100 cc. have been distilled over, when the $N/2$ sulphuric acid is titrated against a standard alkali.

The number of cubic centimetres of $N/2$ sulphuric acid used $\times 0.007$ equals the weight of the nitrogen.

Gypsum.

SAMPLING.—The gross sample is collected by increments from the consignment and should weigh at least 1 cwt. The reduction of this sample should



proceed on the same lines as for fuel, one sample being retained as a moisture sample, and the remainder crushed to $\frac{1}{4}$ in. or finer and reduced by a sample divider or by quartering to a 10-lb. sample. This is ground to pass a 14-mesh B.S. sieve, air dried at a maximum temperature of 50 deg. C., and reduced to a 2-lb. sample by a mechanical sample divider. This is again ground to pass a 36-mesh B.S. sieve, mixed, and reduced to a 4-oz. sample, which is finally ground to pass a 100-mesh B.S. sieve, mixed, and stored in an airtight bottle for analysis. Care should be taken to see that the drying of the sample for analysis is not done at too high a temperature, since water of crystallisation of gypsum is partially expelled at 105 deg. C.

DETERMINATION OF SILICA.—One gramme of the sample is weighed into a 6-in. porcelain basin, moistened with a small amount of water, and 10 cc. of concentrated hydrochloric acid are added. The basin is then covered with a clock-glass and evaporated slowly to dryness on a hot plate, after which it is maintained on the hot plate for a further half an hour. After cooling, 10 cc. of 1:1 hydrochloric acid are added and the solution is warmed over a low flame for five to ten minutes, any small lumps being broken with the flattened end of a glass rod. The cover and sides of the basin are washed down and the solution decanted on to a 9-cm. No. 40 Whatman filter-paper, the residue being retained in the basin and again treated with 1:1 hydrochloric acid. This process is repeated until all but the small amount of silica and insoluble matter has been dissolved. The silica and insoluble matter having been collected in the filter, the filter is washed until it is free from chlorides, dried, ignited in a muffle furnace, cooled, and weighed. It is then treated with hydrofluoric acid in the manner already described, the loss in weight being the amount of silica.

The total filtrate from the foregoing analysis, including the solution of the silica residue, is collected in a conical beaker and used for the determination of alumina, ferric oxide, lime, and magnesia, using the methods previously described under "Cement" in this Journal for July, 1949.

DETERMINATION OF SULPHATES, LOSS ON IGNITION, AND CARBON DIOXIDE.—These are determined on separate portions of the original sample, using the methods described under "Argillaceous Materials" in this journal, May, 1949.

The sulphates are generally calculated to gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$), the weight of calcium sulphate being multiplied by 1.265 to convert it to gypsum and the water thus combined being deducted from the loss on ignition.

Determining the Alkali Content of Portland Cement.

IN order to save time in the determination of the alkali content of Portland cement, Mr. L. R. Pritchard, chief chemist of the Lone Star Cement Corporation of America, has made use of a Perkin-Elmer flame photometer (model 18A) and describes the results in "Pit and Quarry" for July, 1948. The flame photometer is an instrument for the rapid determination of sodium, potassium, and other metals in solution, and is designed to measure quantitatively the light emitted by various metals when they are excited to spectral emission in a flame. Since the intensity of the light emitted by each element depends primarily on the concentration of its atoms in the flame at any given instant, a measurement of the light intensity produced by a given element makes possible the quantitative determination of that element.

The photometer was standardized, using Portland cement of known alkali content as a standard. By using various amounts of this cement a calibration curve was established for Na_2O and K_2O at concentrations of 0—100 p.p.m. A cement was used as a standard instead of pure compounds because (1) it was difficult to get pure compounds; (2) small errors in using a cement would not affect the alkali content used as much as small errors in using pure compounds; (3) time was not available to study the effect of interfering elements, viscosities of solutions, etc. The results obtained were very satisfactory and encouraging. For example: An alkali determination could be made in ten minutes, including the time of weighing, dissolving a sample, and running it in the flame photometer. The sample was prepared by taking 1 gramme of cement or clinker and dissolving it in 5 ml. of HCl in 25 ml. distilled water. This solution was filtered into a 100-cc. volumetric flask and diluted to volume with distilled water. The flame photometer was balanced; 50 mls. of solution were poured into a 100-cc. beaker and placed under the atomizer. The needle was brought to balance with the ratio dial and the concentration of Na_2O and K_2O in p.p.m. was read from the calibration curve. The atomizer tube was then washed out with distilled water, the zero point checked, and then the instrument was ready for another determination.

A new model (No. 52A) has since been produced with wider applications with which accurate analyses of solutions of sodium, lithium, potassium, magnesium, calcium, strontium, barium, chromium, and manganese can be made. This instrument is an emission spectrometer combined with a flame source and a photo-electric detection system for the measurement of light intensity. The apparatus requires 4 ft. to 6 ft. of laboratory bench space, or a table with a drain, compressed air at a pressure of 30 lb. to 150 lb. per square inch, alternating current electricity at 110 volts, 60 cycles, and acetylene or propane gas in tanks. The sensitivity with a propane flame for sodium, lithium, and potassium is comparable with that with an acetylene flame. The red-sensitive phototube is suitable for sodium, lithium, and potassium, so that it is possible to determine soda and potash without changing tubes. The photometer must be standardized

by calibrating with solutions containing known concentrations of the elements to be determined. The output meter of the instrument reads proportionately to the intensity of light emitted by the sample put into it ; therefore it is necessary to convert the meter readings (or ratio readings) into terms of concentrations most convenient to the analyst. There are several variables, such as air pressure to the atomizer, gas pressure to the burner, chemical composition and viscosity of a sample, etc., which are impossible to eliminate. It has been found that the "internal standard" method of operation, which compares the light of the element to be determined directly to the light emitted by the element lithium, causes smaller errors in the results obtained. The photometer was standardized for using lithium nitrate, CP soda, CP potash, and CP calcium carbonate to prepare standard solutions of various concentrations. Standardization curves were developed for Na_2O and K_2O of concentrations varying from 0 to 100 p.p.m. Cement samples are brought into solution in the same manner as for SO_3 determination according to the A.S.T.M. Manual. The solution is then filtered into a 100-ml. volumetric flask and after the addition of the "internal standard" made up to a final volume of 100 cc. The solution is poured into the atomizer and the instrument is balanced with the internal standard dial. Then the standard solution is added to the atomizer and the meter balanced again with the internal standard dial ; the balance positions are recorded ; check readings are obtained ; and then the average values are converted to concentrations by means of a calibration curve. The percentages of soda and potash are obtained in a few minutes instead of two days by the gravimetric method.

The performance of the photometer depends to a large extent on the skill of the operator. If skilfully and intelligently used, it is very useful for the determination of alkalis in Portland cement, saving a great amount of analytical time. After the instrument has been standardized and the operating process developed, it can be operated by a laboratory assistant. It has many applications in water analyses and it has possibilities in quick determinations of calcium, magnesium, and barium.

The Cement Industry in India.

At the time of the partition of India in 1947 there were 19 cement factories, with a total capacity of 2,245,000 tons per annum, in the Indian Union. The Government of undivided India had sanctioned new schemes of which 29, with a total annual capacity of 2,820,000 tons, were to be in the Indian Union. Since then five of these schemes have been cancelled and seven new ones have been sanctioned. The nineteen cement factories in the Indian Union produced a total of 1,186,704 tons in the nine months April 1 to December 31, 1948.

The capacity of the existing cement works in India, and of the extensions in progress, are as follows in tons per annum.

Works of the Associated Cement Companies, Ltd. : Present capacity 1,857,000 tons. New capacity to be installed by the year 1952, 732,000 tons.

Works of the Dalmia Cement Co., Ltd. : Present capacity 260,000 tons. New capacity to be installed by 1951, 600,000 tons.

Sone Valley Portland Cement Co., Ltd., present capacity 200,000 tons. Andra Cement Co., Ltd. : Present capacity 30,000 tons. New capacity to be installed by 1950, 60,000 tons. Mysore Iron & Steel Co., Ltd. : Present capacity 20,000 tons. New capacity to be installed by the end of 1949, 60,000 tons. Kalyanpur Lime & Cement Co., Ltd. : Present capacity 36,000 tons. Jhajha Cement Co., Ltd. : Present capacity 12,000 tons. Capacity to be installed later, 30,000 tons.

New works now under construction and which are to be completed this year are : Works at Jambagar for the Shree Digvijay Company, 100,000 tons a year. Works in Madras Province for Indian Cements, Ltd., 1,000 tons. Works at Travancore for Travancore Cements, Ltd., 50,000 tons. A new works at Sindhri for the Government of India with a capacity of 200,000 tons is to be completed in 1951.

Other proposed new works, for which no dates for completion are yet available, are as follows : At Markundi for the United Provinces Government, 200,000 tons. In Bombay Province for the Bagalket Cement Co., 100,000 tons. In Central Province for the New Hindustan Cement Co., Ltd., 100,000 tons. In Madras Province at Kurnool 100,000 tons and at South Arcot 50,000 tons. In Assam for the Assam Government, 100,000 to 150,000 tons. In Rewa for the Rewa State Government, 100,000 to 150,000 tons. In Baroda State for M. N. Dalal, 100,000 tons. In Bombay Province for C.C. Mankiwala, 100,000 tons.

The present capacity of the cement works in India is 2,415,000 tons. New works and extensions now under construction and which are to be completed before the year 1952, will have a capacity of 1,932,000 tons. New works proposed but not yet started will have a capacity of more than a million tons. The present programme is therefore to increase the productive capacity of the cement industry in India from 2,415,000 tons a year to more than 5,000,000 tons.

Plant for a New Cement Factory.

Acting as sub-contractors to Messrs. Vickers-Armstrongs, Ltd., the Brush Electrical Engineering Co., Ltd., have received an order to the value of over £350,000 for the main power station and all the electrical equipment, including the main kiln motors, for the new United Provinces Government cement factory to be erected at Robertsganj, near Mirzapur. The plant will include three Brush Ljungstrom 2,400-kW. turbo-alternators ; they will operate on steam conditions of 325 lb. per square inch and 725 deg. F., and will each be arranged on the unit principle with a 30,000-lb.-per-hour water-tube boiler with superheaters, stokers, economisers, induced and forced draught fans, water-treatment plant, feed pumps, and coal and ash handling plant.

Patents Relating to Cement Manufacture.

Refractory Materials.

In a refractory composition, synthetic crystalline magnesium orthosilicate is formed in the interstices between the grains of an acid, basic, or neutral refractory material, for example, silica, magnesia, or chrome ore, by the interaction of finely-divided magnesia and silica. The magnesia in the magnesia-silica mixture may be slightly in excess of the amount required for correct synthesis of the magnesium ortho-silicate in order to correct impurities in the other materials. The basic refractory material is ground to less than 4 mm. size, and dust below 0.1 mm., and preferably below 1 mm., is removed. The magnesium orthosilicate components should either or both be of amorphous nature and of particle-sizes of 0.01 to 0.005 mm. for the magnesia and 0.002 to 0.0005 mm. for the silica. The magnesia is preferably that collected by electrostatic precipitation from the flue gases from the production of dead-burned magnesite, while the silica may be that obtained from the exhaust gases produced in the production of ferro-silicon by the reduction of quartz by carbon in the presence of steel scrap, or by the reoxidation of silicon vapour obtained in the reduction of silica by carbon at high temperatures. The mixture of the components of the composition is pressed to shape, air-dried, and heated to remove moisture and, if necessary, to dehydrate any hydrated magnesium silicates in the material, and then heated to the temperature of reaction of the magnesia and silica but below the point of fusion of the components. Examples are: (a) 60 to 85 parts of dead-burned magnesia are mixed with 40 to 15 parts of the magnesia-silica mixture containing 4 parts of magnesia to 3 parts of silica, and 1 to 4 per cent. of a temporary binder such as a solution of magnesium sulphate of chloride is added, the mixture being used as a ramming-mixture or being pressed to shape under 1000 lb. or, preferably 5000 lb. to 10,000 lb., per square inch and burnt at 1400 to 1600 deg. C.; (b) 60 to 80 parts of olivine rock may be used in place of the

magnesia, an excess of magnesia being used with the silica to convert any iron oxide to magnesium ferrite; (c) 70 to 85 parts of chrome ore are used and 4 per cent. of kaolin is added to increase crushing strength.—No. 579,098. Permanente Cement Co. July 17, 1944.

Dust Removal.

Means for removing dust from flue gases comprise a concentrator for intensifying a dust film around the inside of the chimney wall, which film is sucked out by a fan through slots in the wall to a dust collector and cleaner, the cleaned gas being reintroduced through an inlet below outlet slots in such a way as to cause the chimney gases to rotate. As shown, cleaned gas is forced by a fan (12) up the pipe (13) and through an opening (14) arranged tangentially in relation to the flue (1), thus bringing the flue gases into rotation which, with the aid

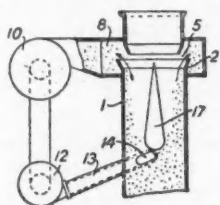


Fig. 1.

of a streamlined body (17), causes the heavier dust particles to be thrown towards the chimney wall. On reaching a collar (2) the film of dusty gas is sucked through the outlet slit (5) into a circular channel (8) whence it passes to a dust collector (10), and the cleaned gas is then drawn into the fan (12). The inlet (14) may be provided with adjustable nozzles to regulate the chimney draught. Any number of fans and dust collectors may be used.—No. 577,966. T. C. Bieth. January 17, 1945.

BOUND VOLUMES OF "CEMENT AND LIME MANUFACTURE".

It is now possible again to bind volumes of "Cement & Lime Manufacture" and to supply cloth-covered binding cases lettered in gold on the spine with the title, volume number, and year of publication. Copies for binding should be sent post paid to Concrete Publications, Ltd., 14, Dartmouth Street, London, S.W. 1. Where possible missing numbers will be supplied at the published price to make up incomplete sets, but as many numbers published during the past few years are not available it is advisable to ask the publishers whether they have the numbers required before sending incomplete sets. The cost of the cases is 5s. for each volume. The cost of supplying a case and binding a volume is 10s. 9d., including packing and carriage.